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SOLAR/1050-79/04

Monthly Performance Report

BOND CONSTRUCTION

APRIL 1979

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

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MONTHLY PERFORMANCE REPORT

BOND CONSTRUCTION

APRIL 1979

I. SYSTEM DESCRIPTION

The Bond Construction site is a single-family residence in Gladstone, Missouri. The home has approximately 1400 square feet of conditioned space. Solar energy is used for space heating the home and preheating domestic hot water (DHW). The solar energy system has an array of flat-plate collectors with a gross area of 465 square feet. The array faces south at an angle of 37 degrees to the horizontal. A propylene glycol solution is the transfer medium that delivers solar energy from the collector array to an external heat exchanger. Water is the transfer medium that delivers solar energy from the external heat exchanger to storage and from storage to the hot water load and liquid-to-air heat exchanger in the furnace. Air is the transfer medium that delivers solar energy to the space heating load. Solar energy is stored in the basement in an 800-gallon steel storage tank with walls approximately 1/4-inch thick. The storage tank has 4-inch polyurethane insulation on the bottom and 8-inch fiberglass insulation on the top and sides. Preheated city water is stored in an 82-gallon DHW tank. When solar energy is insufficient to satisfy the space heating load, a gas furnace provides auxiliary energy for space heating. Similarly, an electrical immersion heater in the DHW tank provides auxiliary energy for heating the supply water. Solar energy is transferred from the storage tank to the hot-air heating system by a liquid-to-air heat exchanger contained in the furnace ductwork; solar energy is transferred from the storage tank to the DHW tank by an annular heat exchanger jacket around the hot water tank. The house also contains a fireplace with an integral fan; the fireplace is only instrumented for monitoring fan power consumption. The system, shown schematically in Figure 1, has 5 modes of solar operation.

Mode 1 - Collector-to-Storage: This mode activates when there is a temperature difference of 20°F between a control sensor located at the collector and a control sensor located inside the storage tank (near the bottom). At this time the controller turns on both the collector and storage circuit

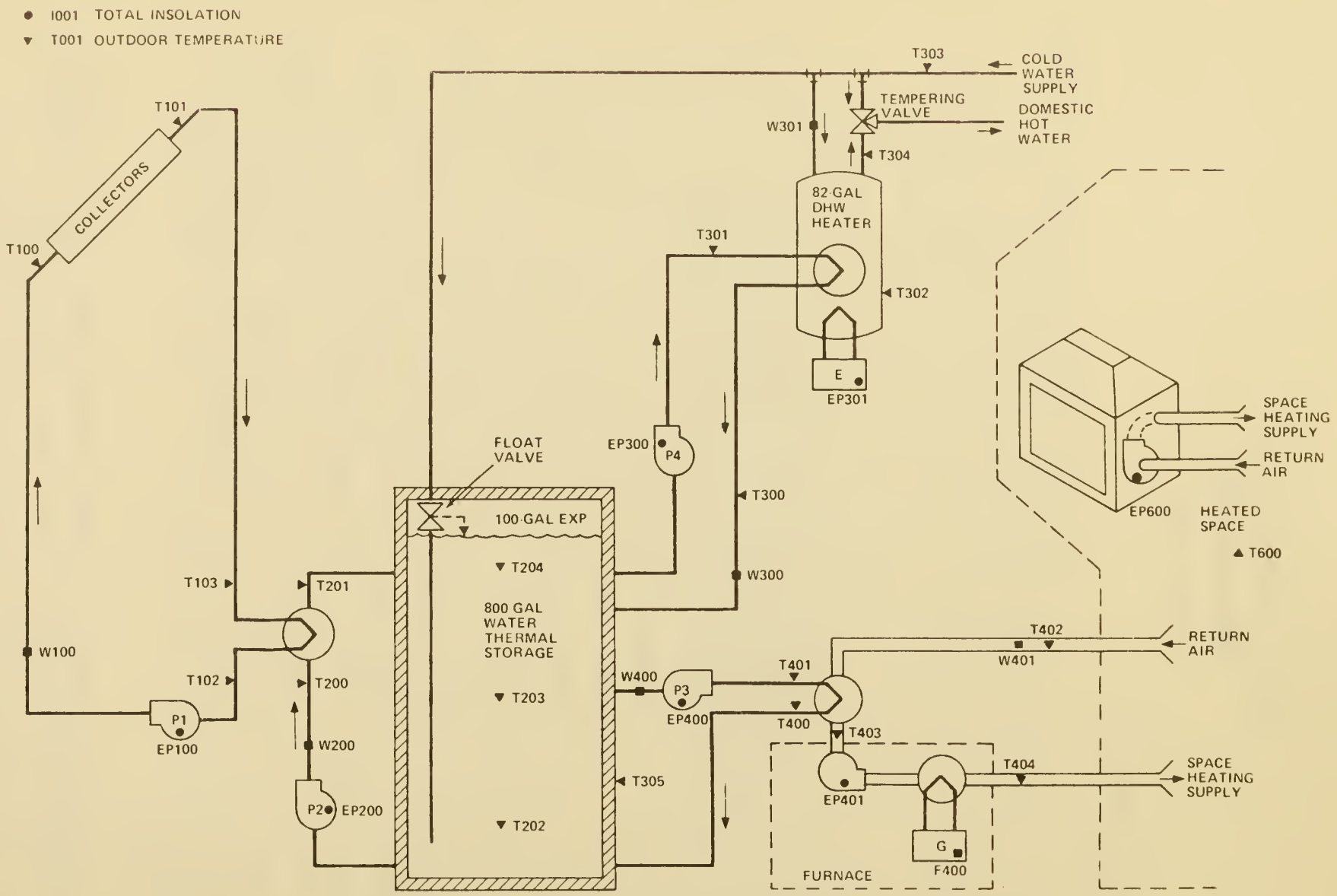

Figure 1. BOND CONSTRUCTION CO. SOLAR ENERGY SYSTEM SCHEMATIC

pumps (P1 and P2, respectively). Solar energy is transferred from the collector to the storage tank by an external heat exchanger. Both pumps continue to operate until the temperature difference is less than 5°F; the controller then turns both pumps off.

Mode 2 - Storage-to-Space Heating: This mode activates when the room temperature drops to the setting on the house thermostat. At this point, this mode is initiated if the storage temperature, measured by a control sensor inside the tank (near the top), is higher than 95°F. If so, the furnace circuit pump (P3) turns on and hot water circulates from the storage tank through a liquid-to-air heat exchanger in the furnace. At the same time the furnace fan turns on, forcing air past the heat exchanger, thereby transferring the solar energy to the heating load. If the room temperature drops an additional increment (set point), the auxiliary gas burner turns on to provide auxiliary energy to the heating load. If storage temperature falls to 90°F while in this mode, the mode terminates. However, the fan and gas furnace continue to supply energy until the thermostat demand is satisfied. If the storage temperature is below 95°F when the room thermostat calls for heat, this mode does not activate; auxiliary energy is then provided by the gas furnace. The pump, fan and burner (if on) are turned off when the room temperature exceeds the thermostat setting.

Mode 3 - Storage-to-DHW: This mode activates when there is a temperature difference of 10°F between the control sensor located inside the storage tank (near the top) and the control sensor located in the hot water tank (near the middle). This mode terminates when the temperature difference drops to 3°F. When this mode activates, pump P4 circulates hot water from the storage tank through an annular jacket surrounding the hot water tank; energy is thereby transferred to the water in the hot water tank. The electric immersion heater in the hot water tank turns on to provide auxiliary energy to the DHW if the temperature in the hot water tank drops below its thermostat setting.

Mode 4 - Elimination of Excess Heat in Summer: This mode activates when the storage tank temperature, as determined by an aquastat located in the tank, exceeds 180°F. At this time the collector and storage circuit pumps (P1 and P2, respectively) are activated, thereby transferring energy from the storage tank to the collector by way of the external heat exchanger. This energy is then radiated from the collector to the atmosphere. This mode continues until the storage temperature drops below 180°F.

Mode 5 - Snow Removal in Winter: This mode activates when the collector and storage circuit pumps (P1 and P2) are manually switched on in order to melt the snow that has accumulated on the collector.

II. PERFORMANCE EVALUATION

INTRODUCTION

The site was unoccupied in April; however, the solar energy system operated continuously during the month. Solar energy satisfed 51 percent of the space heating requirements. The solar energy system provided fossil fuel energy savings of 1.8 million Btu and incurred an electrical energy expense of 0.11 million Btu. The control problem causing intermittent cycling of mode 1 during periods of good insolation continued throughout the month. Mode 1 operated for about 65 percent of the time that potential mode 1 conditions existed during the month. There was no hot water load during April, since the water was turned off.

WEATHER CONDITIONS

During the month, total incident solar energy on the collector array was 19.6 million Btu for a daily average of 1407 Btu per square foot. This was below the estimated average daily solar radiation for this geographical area during April of 1615 Btu per square foot for a south-facing plane with a tilt

of 37 degrees to the horizontal. The average ambient temperature during April was 51°F as compared with the long-term average for April of 54°F. The number of heating degree-days for the month (based on a 65°F reference) was 397, as compared with the long-term average of 336.

THERMAL PERFORMANCE

System - During April the solar energy system performed somewhat poorer than expected. The expected performance was determined from a modified f-chart analysis using measured weather and subsystem loads as inputs. Solar energy collected was 3.0 million Btu versus an estimated 2.9 million Btu. Solar energy used by the system was estimated by assuming that all energy collected would be applied to the load. Actual solar energy used was 1.8 million Btu. System total solar fraction was 51 percent versus an estimated 100 percent. The poor performance is attributed to the cycling of mode 1 during periods of good insolation. This is discussed further in the "Observations" section below.

Collector - The total incident solar radiation on the collector array for the month of April was 19.6 million Btu. During the period the collector loop was operating, the total insolation amounted to 5.0 million Btu. The total collected solar energy for the month of April was 3.0 million Btu, resulting in a collector array efficiency of 15 percent, based on total incident insolation. Solar energy delivered from the collector array to storage was 3.0 million Btu. Energy loss during transfer from the collector array to storage was 0.027 million Btu. This loss represented 1 percent of the energy collected. Operating energy required by the collector loop was 0.081 million Btu.

Storage - Solar energy delivered to storage was 3.0 million Btu. There were 1.8 million Btu delivered from storage to the DHW and space heating subsystems. Energy loss from storage was 1.0 million Btu. This loss represented 32 percent of the energy delivered to storage. The storage efficiency was 68 percent: This is calculated as the ratio of the sum of the energy removed from

storage and the change in stored energy, to the energy delivered to storage. The average storage temperature for the month was 117°F.

DHW Load - The DHW subsystem consumed 0.73 million Btu of solar energy. There was no hot water load since the water was turned off. The DHW subsystem consumed a total of 0.020 million Btu of operating energy, resulting in an electrical energy expense of 0.020 million Btu. This subsystem is discussed further in the "Observations" section.

Space Heating Load - The space heating subsystem consumed 1.1 million Btu of solar energy and 2.3 million Btu of auxiliary fossil fuel energy to satisfy a space heating load of 2.1 million Btu. The solar fraction of this load was 51 percent. The space heating subsystem consumed a total of 0.12 million Btu of operating energy, resulting in an electrical energy expense of 0.009 million Btu. It also provided a fossil fuel energy savings of 1.8 million Btu.

OBSERVATIONS

Continued cycling of mode 1 during periods of good insolation resulted in degraded collector performance throughout the entire month. On April 21 the grantee relocated the collector control sensor to make its reading more representative of the collector fluid temperature. In addition, the control temperature differentials of mode 1 were changed from 20°F (on)/5°F (off) to 12°F (on)/4°F (off). However, due to an apparent problem within the controller, mode 1 appears to deactivate at an 11°F temperature differential. The grantee will replace the defective controller as soon as a replacement controller is available.

The flow sensor in the storage to DHW heater loop (W300) was defective. Therefore, the design flow of three gallons per minute was used to determine the amount of solar energy delivered from storage to the DHW subsystem during April. The operating energy consumed by the DHW subsystem during mode 3 operation was considered to be an electrical energy expense since there was no

DHW load during the month; therefore, the solar energy transfer from storage to the DHW heater served no useful purpose. (The house was unoccupied and the water was turned off.)

Anomalies in two of the three storage temperature sensors required that the storage temperature be based on the single operating sensor. Since this sensor measures the temperature at the top of the tank, the reported average storage temperature is probably higher than the true average storage temperature.

The performance factors show a loss of 0.027 million Btu between the collector and input to storage. This loss represents 1 percent of the energy collected during April. Since there is a heat exchanger (HX) between the collector and storage, this low energy loss is suspect. Analysis shows an energy gain between the collector and the HX input. An analysis of temperature differentials in the collector loop during mode 1 indicates that T100, collector input, may be reading high. The calibration of this sensor, and the other temperature sensors in the collector loop, should be checked to verify that accurate temperature measurements are being recorded.

ENERGY SAVINGS

The solar energy system provided a total fossil fuel energy savings of 1.8 million Btu and incurred an electrical energy expense of 0.11 million Btu. The DHW subsystem incurred an electrical energy expense of 0.020 million Btu. The space heating subsystem incurred an electrical energy expense of 0.009 million Btu and provided a fossil fuel energy savings of 1.8 million Btu.

III. ACTION STATUS

The grantee will replace the collector controller in May. Boeing must resolve the instrumentation sensor anomalies and check the calibration of the collector loop temperature sensors on their next site visit. No visit is scheduled at this time.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI SOLAR/1050-79/04
REPORT PERIOD: APRIL,1979

SITE/SYSTEM DESCRIPTION:
BOND CONSTRUCTION IS A SINGLE FAMILY DWELLING. THE SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING AND HOT WATER. THE COLLECTION/HX LOOP USES A PROPYLENE GLYCOL SOLUTION AS AN ENERGY TRANSFER MEDIUM. THE HX/STORAGE LOOP USES WATER FOR ENERGY TRANSFER AND WATER IS THE STORAGE MEDIUM. THE STORAGE TANK PROVIDES SOLAR ENERGY FOR SPACE HEATING AND DHW THROUGH HX LOOPS. A GAS FURNACE PROVIDES AUXILIARY SPACE HEAT AS REQUIRED. AUXILIARY HEAT FOR THE DHW IS SUPPLIED ELECTRICALLY.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	19.646	MILLION BTU
	42214	BTU/SQ.FT.
COLLECTED SOLAR ENERGY	2.984	MILLION BTU
	6412	BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	51	DEGREES F
AVERAGE BUILDING TEMPERATURE	65	DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.09	
ECSS OPERATING ENERGY	0.081	MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	0.224	MILLION BTU
TOTAL ENERGY CONSUMED	5.511	MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	0.000	2.143	N.A.	2.143 MILLION BTU
SOLAR FRACTION	0	51	N.A.	51 PERCENT
SOLAR ENERGY USED	0.725	1.099	N.A.	1.824 MILLION BTU
OPERATING ENERGY	0.020	0.123	N.A.	0.224 MILLION BTU
AUX. THERMAL ENERGY	0.000	1.043	N.A.	1.043 MILLION BTU
AUX. ELECTRIC FUEL	0.000	N.A.	N.A.	0.000 MILLION BTU
AUX. FOSSIL FUEL	N.A.	2.308	N.A.	2.308 MILLION BTU
ELECTRICAL SAVINGS	-0.020	-0.009	N.A.	-0.110 MILLION BTU
FOSSIL SAVINGS	N.A.	1.832	N.A.	1.832 MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.702

* DENOTES UNAVAILABLE DATA
â DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI SOLAR/1050-79/04
REPORT PERIOD: APRIL,1979

SITE/SYSTEM DESCRIPTION:
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GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	20.727	GIGA JOULES
	479380	KJ/SQ.M.
COLLECTED SOLAR ENERGY	3.148	GIGA JOULES
	72810	KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	11	DEGREES C
AVERAGE BUILDING TEMPERATURE	18	DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.09	
ECSS OPERATING ENERGY	0.085	GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	0.236	GIGA JOULES
TOTAL ENERGY CONSUMED	5.814	GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	0.000	2.261	N.A.	2.261 GIGA JOULES
SOLAR FRACTION	0	51	N.A.	51 PERCENT
SOLAR ENERGY USED	0.764	1.160	N.A.	1.924 GIGA JOULES
OPERATING ENERGY	0.021	0.130	N.A.	0.236 GIGA JOULES
AUX. THERMAL ENG	0.000	1.101	N.A.	1.101 GIGA JOULES
AUX. ELECTRIC FUEL	0.000	N.A.	N.A.	0.000 GIGA JOULES
AUX. FOSSIL FUEL	N.A.	2.435	N.A.	2.435 GIGA JOULES
ELECTRICAL SAVINGS	-0.021	-0.010	N.A.	-0.116 GIGA JOULES
FOSSIL SAVINGS	N.A.	1.933	N.A.	1.933 GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.702

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978. SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI
REPORT PERIOD: APRIL,1979

SOLAR/1050-79/04

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.092	38	0.000	N	0.000	0.000	0.000
2	0.308	37	0.000	O	0.000	0.000	0.000
3	0.243	34	0.000	T	0.000	0.000	0.000
4	0.477	38	0.000		0.002	0.000	0.000
5	1.117	46	0.040	A	0.010	0.000	0.036
6	0.893	34	0.190	F	0.002	0.000	0.212
7	0.989	58	0.080	P	0.008	0.000	0.081
8	0.453	50	0.012	L	0.000	0.000	0.027
9	0.699	39	0.131	I	0.003	0.000	0.188
10	0.343	42	0.142	C	0.001	0.000	0.414
11	0.240	54	0.016	A	0.000	0.000	0.066
12	0.509	52	0.000	E	0.002	0.000	0.000
13	1.028	53	0.000	L	0.009	0.000	0.000
14	1.103	59	0.000	E	0.004	0.000	0.000
15	1.008	59	0.000		0.000	0.000	0.000
16	0.982	61	0.000		0.000	0.000	0.000
17	0.639	62	0.000		0.000	0.000	0.000
18	0.396	63	0.000		0.000	0.000	0.000
19	0.251	67	0.000		0.000	0.000	0.000
20	0.229	60	0.215		0.000	0.000	0.935
21	1.133	56	0.021		0.000	0.000	0.019
22	1.068	59	0.012		0.000	0.000	0.011
23	0.320	59	0.056		0.008	0.000	0.176
24	0.273	62	0.000		0.000	0.000	0.000
25	*	*	*		*	*	*
26	1.024	54	0.169		0.009	0.000	0.165
27	1.059	48	0.232		0.007	0.000	0.219
28	0.976	52	0.167		0.008	0.000	0.171
29	0.918	51	0.141		0.004	0.000	0.154
30	0.222	46	0.139		0.000	0.000	0.627
SUM	19.646	-	1.824	N.A.	0.081	0.000	-
AVG	0.655	51	0.061	N.A.	0.003	0.000	0.093
NBS ID	0001	N113			0102		N111

* DENOTES UNAVAILABLE DATA.
0 DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI SOLAR/1050-79/04
REPORT PERIOD: APRIL, 1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.092	0.000	0.000	40	0.000
2	0.308	0.000	0.000	40	0.000
3	0.243	0.000	0.000	39	0.000
4	0.477	0.074	0.050	38	0.105
5	1.117	0.654	0.334	61	0.299
6	0.893	0.170	0.155	38	0.174
7	0.989	0.540	0.303	72	0.306
8	0.453	0.000	0.000	46	0.000
9	0.699	0.218	0.187	43	0.267
10	0.343	0.025	0.022	45	0.064
11	0.240	0.000	0.000	54	0.000
12	0.509	0.091	0.085	51	0.166
13	1.028	0.636	0.300	59	0.292
14	1.103	0.322	0.268	64	0.243
15	1.008	0.012	0.025	68	0.025
16	0.982	0.000	0.000	68	0.000
17	0.639	0.000	0.000	66	0.000
18	0.396	0.000	0.000	69	0.000
19	0.251	0.000	0.000	70	0.000
20	0.229	0.009	0.004	62	0.018
21	1.133	0.000	0.000	62	0.000
22	1.068	0.000	0.000	67	0.000
23	0.320	0.183	0.051	64	0.160
24	0.273	0.000	0.000	64	0.000
25	*	*	*	*	*
26	1.024	0.603	0.352	60	0.344
27	1.059	0.520	0.274	51	0.259
28	0.976	0.517	0.275	58	0.282
29	0.918	0.239	0.199	54	0.217
30	0.222	0.000	0.000	46	0.000
SUM	19.646	4.976	2.584	-	-
AVG	0.655	0.166	0.099	56	0.152
RESID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI SOLAR/1050-79/04
REPORT PERIOD: APRIL,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.000	0.000	-0.020	89	1.000
2	0.000	0.000	-0.013	87	1.000
3	0.000	0.000	-0.017	84	1.000
4	0.062	0.000	0.046	86	0.750
5	0.329	0.040	0.279	113	0.970
6	0.141	0.190	-0.155	117	0.244
7	0.309	0.080	0.134	114	0.692
8	0.000	0.012	-0.044	127	1.000
9	0.169	0.131	-0.017	116	0.681
10	0.023	0.142	-0.149	105	-0.329
11	0.000	0.016	-0.056	92	1.000
12	0.084	0.000	0.045	93	0.533
13	0.312	0.000	0.262	117	0.840
14	0.276	0.000	0.156	149	0.567
15	0.023	0.000	-0.029	158	-1.254
16	0.000	0.000	-0.058	152	1.000
17	0.000	0.000	-0.052	144	1.000
18	0.000	0.000	-0.048	135	1.000
19	0.000	0.000	-0.047	128	1.000
20	0.003	0.215	-0.083	119	40.547
21	0.000	0.021	-0.037	108	1.000
22	0.000	0.012	-0.038	103	1.000
23	0.067	0.056	0.001	100	0.862
24	0.000	0.000	-0.015	99	1.000
25	*	*	*	*	*
26	0.324	0.169	0.209	112	1.168
27	0.276	0.232	0.029	134	0.944
28	0.262	0.167	0.034	133	0.767
29	0.198	0.141	0.048	143	0.954
30	0.000	0.139	-0.192	132	1.000
SUM	2.957	1.824	0.180	-	-
AVG	0.099	0.061	0.006	117	0.678
NES ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI
REPORT PERIOD: APRIL,1979

SOLAR/1050-79/04

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.000	0	0.000	0.000	0.000	0.000	NOT APPLICABLE	0.000	NOT APPLICABLE	60	140	0
2	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
3	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
4	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
5	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
6	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
7	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
8	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
9	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
10	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
11	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
12	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
13	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
14	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
15	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
16	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
17	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
18	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
19	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
20	0.000	0	0.212	0.004	0.000	0.000		-0.004		60	140	0
21	0.000	0	0.007	0.001	0.000	0.000		-0.001		60	140	0
22	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
23	0.000	0	0.056	0.003	0.000	0.000		-0.003		60	140	0
24	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
25	*	*	*	*	*	*		*		*	*	*
26	0.000	0	0.169	0.004	0.000	0.000		-0.004		60	140	0
27	0.000	0	0.093	0.003	0.000	0.000		-0.003		60	140	0
28	0.000	0	0.069	0.002	0.000	0.000		-0.002		60	140	0
29	0.000	0	0.094	0.003	0.000	0.000		-0.003		60	140	0
30	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
SUM	0.000	-	0.725	0.020	0.000	0.000	N.A.	-0.020	N.A.	-	-	0
AVG	0.000	0	0.024	0.001	0.000	0.000	N.A.	-0.001	N.A.	60	140	0
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: BOND CONSTRUCTION GLADSTONE, MISSOURI SOLAR/1050-79/04
REPORT PERIOD: APRIL,1979

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	CREF ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.188	0	0.000	0.009	0.188	N	0.328	0.000	0.000	59	38
2	0.213	0	0.000	0.011	0.213	O	0.396	0.000	0.000	61	37
3	0.194	0	0.000	0.011	0.194	T	0.382	0.000	0.000	61	34
4	0.144	0	0.000	0.008	0.144		0.256	0.000	0.000	60	38
5	0.123	32	0.040	0.006	0.083	A	0.145	-0.000	0.066	62	46
6	0.190	100	0.190	0.011	0.000	F	0.017	-0.002	0.316	60	34
7	0.087	93	0.080	0.006	0.006	P	0.036	-0.001	0.134	64	58
8	0.013	99	0.012	0.001	0.000	L	0.018	-0.000	0.021	66	50
9	0.131	100	0.131	0.007	0.000	I	0.023	-0.001	0.219	61	39
10	0.143	99	0.142	0.009	0.001	C	0.023	-0.001	0.236	60	42
11	0.044	36	0.016	0.004	0.028	A	0.077	-0.000	0.026	61	54
12	0.009	0	0.000	0.001	0.009	E	0.034	0.000	0.000	62	52
13	0.056	0	0.000	0.003	0.056	L	0.113	-0.000	0.000	63	53
14	0.000	0	0.000	0.000	0.000	E	0.012	0.000	0.000	65	59
15	0.000	0	0.000	0.000	0.000		0.011	0.000	0.000	66	59
16	0.000	0	0.000	0.000	0.000		0.023	0.000	0.000	69	61
17	0.000	0	0.000	0.000	0.000		0.019	0.000	0.000	69	62
18	0.000	0	0.000	0.000	0.000		0.016	0.000	0.000	69	63
19	0.000	0	0.000	0.000	0.000		0.015	0.000	0.000	70	67
20	0.013	18	0.002	0.010	0.010		0.023	-0.000	0.004	70	60
21	0.015	96	0.014	0.001	0.001		0.017	-0.000	0.024	67	56
22	0.013	97	0.012	0.001	0.000		0.012	-0.000	0.020	68	59
23	0.000	0	0.000	0.000	0.000		0.018	-0.000	0.000	68	59
24	0.000	0	0.000	0.000	0.000		0.018	0.000	0.000	68	62
25	*	*	*	*	*		*	*	*	*	*
26	0.072	0	0.000	0.004	0.072		0.134	0.000	0.000	66	54
27	0.139	100	0.139	0.006	0.000		0.016	-0.001	0.232	65	48
28	0.097	100	0.097	0.008	0.000		0.020	-0.001	0.162	66	52
29	0.048	98	0.047	0.002	0.001		0.020	-0.000	0.079	66	51
30	0.141	99	0.139	0.006	0.001		0.012	-0.001	0.232	65	46
SUM	2.143	-	1.099	0.123	1.043	N.A.	2.308	-0.009	1.832	-	-
AVG	0.071	51	0.037	0.004	0.035	N.A.	0.077	-0.000	0.061	65	51
NBS	Q402	N400	G400	G403	G401		Q410	Q415	Q417	N406	N113

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: ECNO CONSTRUCTION GLADSTONE, MISSOURI
REPORT PERIOD: APRIL,1979

SOLAR/1050-79/04

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	198	N	38	40	N	N	N
2	663	O	37	40	O	O	O
3	521	T	34	39	T	T	T
4	1026		38	38			
5	2399	A	46	61	A	A	A
6	1920	P	34	38	P	P	P
7	2126	P	58	72	P	P	P
8	973	L	50	46	L	L	L
9	1502	I	39	43	I	I	I
10	737	C	42	45	C	C	C
11	517	A	54	54	A	A	A
12	1093	B	52	51	B	B	B
13	2209	L	53	59	L	L	L
14	2369	E	59	64	E	E	E
15	2166		59	68			
16	2110		61	68			
17	1373		62	66			
18	850		63	69			
19	539		67	70			
20	493		60	62			
21	2435		56	62			
22	2294		59	67			
23	687		59	64			
24	587		62	64			
25	*		*	*			
26	2201		54	60			
27	2276		48	51			
28	2097		52	58			
29	1972		51	54			
30	477		46	46			
SUM	42214	N.A.	-	-	-	-	-
AVG	1407	N.A.	51	56	N.A.	N.A.	N.A.
NBS ID	G001		N113			N115	N114

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